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JOINT INSTITUTE FOR ADVANCEMENT OF FLIGHT SCIENCES

Program of Research in Flight Dynamics in the JIAFS at NASA-Langley Research Center

NASA Cooperative Agreement NCC1-29

Semi-Annual Status Report

December 1, 1996 - May 31, 1997

School of Engineering and Applied Science
The George Washington University
Washington, DC 20052

OVERVIEW

The program objectives are fully defined in the original proposal entitled "Program of Research in Flight Dynamics in the JIAFS at NASA-Langley Research Center," which was originated March 20, 1975 and in the renewal of the research program dated December 1, 1997.

The program in its present form includes four major topics:

1. The improvement of existing methods and development of new methods for flight test data analysis,
2. the application of these methods to real flight test data obtained from advanced airplanes,
3. the correlation of flight results with wind tunnel measurements, and theoretical predictions.

The Principal Investigator of the program is Dr. V. Klein. Two Graduate Research Scholar Assistants (G. P. Greiner and T. J. Curry) also participated in the program.

SPECIFIC DEVELOPMENTS

Specific developments in the program during the period December 1, 1996 through May 31, 1997 included:

1. Research on Methods for System Identification.

A research on the analysis of wind tunnel oscillatory data continued. The data were obtained from measurements on the F-16XL and X-31A model.

1.1. F-16XL experimental and data analysis.

Static and small amplitude oscillatory tests were conducted in the 12-foot low speed wind tunnel. From static data some longitudinal derivatives were estimated, for oscillatory data a simple harmonic analysis was used. In figure 1 the variation of lift coefficient with the angle of attack from static and oscillatory tests are shown. Figure 2 presents the in-phase and out-of-phase components of the lift at different reduced frequencies. These types of data were then used in parameter estimation of steady and unsteady aerodynamic parameters. For parameter estimation two types of models are proposed: (a) model of reference 1 where the parameters are estimated at each angle of attack for which the measured data were obtained, (b) model where the parameter variation with the angle of attack is formulated by polynomial splines and an adequate model is determined by stepwise regression. A draft of the NASA TM report is under preparation (in co-operation with Dr. P. C. Murphy).

1.2 X-31A experiment and data analysis.

Small amplitude oscillatory data about all three axes were conducted in the 30- by 60-foot tunnel in 1994. These tests were preceded by extensive static tests. The oscillatory data were re-examined and reformatted for parameter estimation. As an example, the in-phase and out-of-phase components of the normal force for six different reduced frequencies are given in figure 3.

The results of the parameter estimation will be compared with static data and the prediction capabilities of the model determined will be verified. The report (in co-operation with Dr. P. C. Murphy and C. Croom) will also summarized all the oscillatory data available from the experiment which, in addition to the effect of frequencies, also includes the changes in configuration and test conditions.

2. Application of System Identification to Advanced High-Performance Aircraft

The experiment and data analysis of the F-18E/F drop model has been delayed because of an accident in December 1996, during which the model was lost. It is expected that the new model will be available for testing in October 1997.

3. High Speed Civil Transport

Research activities in this period include the incorporation of the Dynamic Aero Servo Elastic (DASE) effects into the Matlab simulation using the updated Cycle 3 High Speed Civil Transport (HSCT) code and data base. These updates require modifications to the Simulink trim block diagram which cascade to the nonlinear sim, the state space linearizer, and the linear sim. Plotting capabilities were also enhanced. This new version was posted early May on the secure web site for user access.

These DASE equations use the generalized mass matrix, modal frequencies, and Rogers' rational function approximation of the unsteady aerodynamics generated from ISAC to allow this flexible structure to deform from the mean body axis during simulated flight. Documentation on the theoretical approach used and it's supporting equations has begun. The final report will be completed in August 1997.

REFERENCES

1. V. Klein and K. D. Noderer: "Modeling of Aircraft Unsteady Aerodynamic Characteristics, Part 2 - Parameters Estimated From Wind Tunnel Data." NASA TM-110161, April 1995.

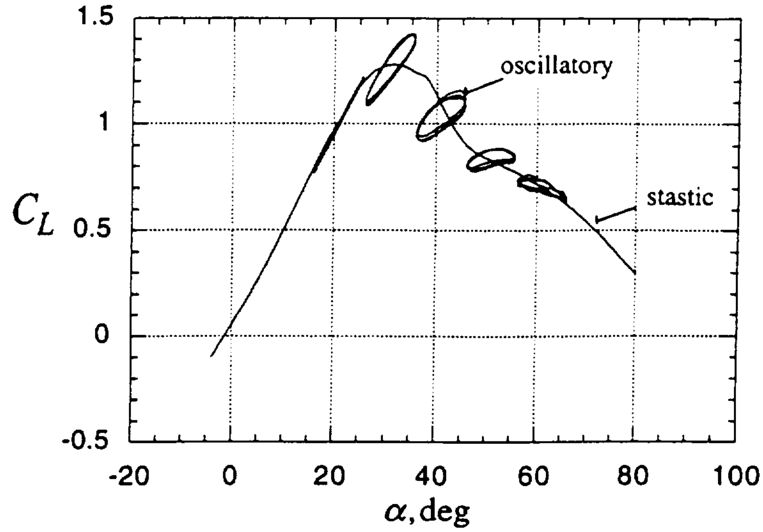

Figure 1. Variation of lift coefficient with angle of attack under static and oscillatory conditions.

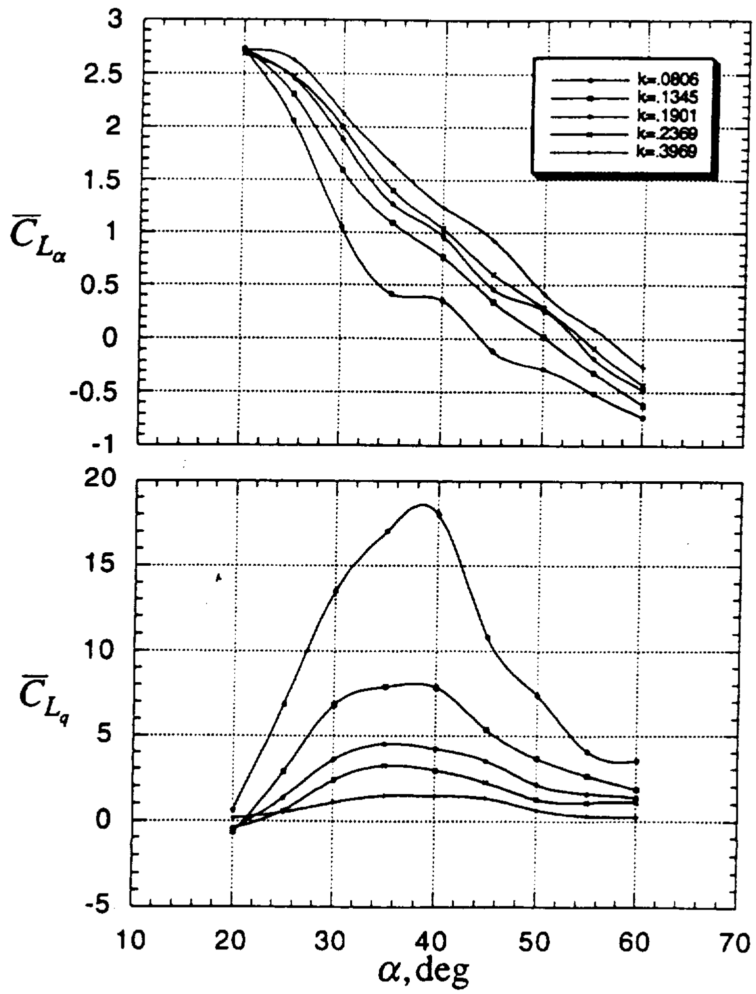

Figure 2. Variation of in-phase and out-of-phase components of lift coefficient with angle of attack for different reduced frequencies.

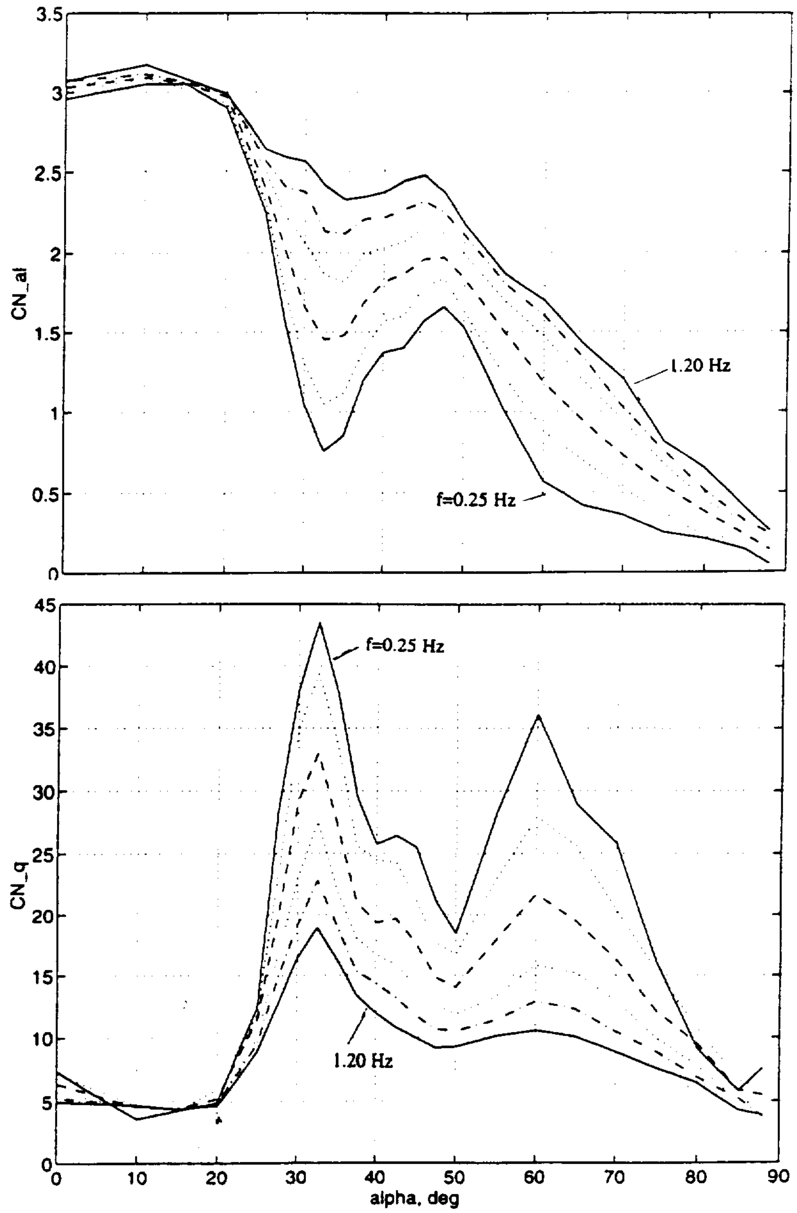

Figure 3. Variation of in-phase and out-of-phase components of normal-force coefficient with angle of attack for different reduced frequencies.